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The teaching machine and programed instruction are explained analytically in terms of laboratory procedures. An explanation is given of the psychology of the student. Teaching machines alleviate some problems of student-teacher relationships, such as apathy, stubbornness, and resentment. Higher levels of concentration are maintained. Some limitations of programed instruction includes danger of commercialization and inflexibility. The program English 2600 was used with the teaching machine in a New York school. The advantages of English 2600 such as presentation of good English grammar and pinpointing of errors, are noted. Practical applications and examples are given to make machine usage more simple.																							
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TEACHING MACHINE 3 AND PROGRAMED INSTRUCTION

A SYMPOSIUM OF VIEWS EXPRESSED

AT AN ALL-COUNCIL MEETING

March 8, 1961

This material comes to you
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Introduction

Herbert F. Johnson,
President of the Council and
Superintendent of Schools
Rockville Centre, N. Y.

My name is Johnson, and I'm the President of the Metropolitan School Study Council. In the name of the Council, I'd like to welcome you to this All-Council meeting. Lest we give credit to the wrong people and fail to give credit to the right people, I'd like you to understand that the meeting this morning has been organized and arranged under the direction of the Chairman's Council--The Local Steering Committee Chairmen--of the Metropolitan School Study Council. The Chairman of the Chairmen's Council is Harold Shafer, Director of Curriculum at Ridgewood, a man who is sitting on our platform. I'd like to introduce him to you at this time--Mr. Shafer.

Mr. Shafer appointed a committee which organized today's session. This committee consists of Milton Michener of Valley Stream as chairman; other members are Sanford Levene of Bronxville, Sidney Salt of Tenafly, William Wright of Greenwich, Robert Cogger of Sewanhaka, and Albert Gorab of Hasbrouck Heights. I think we are all indebted to these people for having organized a program of such significance and timeliness.

All of us in education have been increasingly aware of the fact that the problems which we face seem to mount all the time. Not only are there problems of increasing numbers of children and increasing inadequacy of funds to support education but within the realm of what we teach and how we teach. There have been new ideas, conflicting ideas, and perplexities which, I think, have bothered all of us a great deal. We wonder whether we should teach calculus in high school; whether we should teach algebra to third graders; whether we should have language laboratories; whether we should teach foreign languages in the elementary schools; whether we ought to introduce the high school curriculum into the junior high school; whether we should carry the college curriculum into the high schools; and so on and on. In all of these subjects we find that there are differences of opinion which leave the educator more and more perplexed. There seem to be battles going on all around us--battles of philosophy and points of view. I thought this morning as we came in that--with a bit of nostalgia--some years ago things seemed to be a little more peaceful. There weren't quite as many battles. I thought of Patrick Henry who said, "Gentlemen, many cry peace, peace, but there is no peace!" and that's the way we feel in education today. We wish that it were possible for us to resolve some of the conflicts which perplex us.

One of the points on which there seems to be a good deal of difference of opinion is the extent to which we can use mechanical devices of one kind or another in the improvement of instruction. The purpose of today's meeting is to explore the possibilities in one of these areas which is being widely discussed today: the question of the use, possibilities, the limitations, and the suitability of teaching machines in education.

Now, we are fortunate that we have for our opening session two very well qualified persons to talk with us about this question. The first is Professor B. F. Skinner of Harvard University. I have a very long list of items of information about this distinguished gentleman. I think his importance would deserve a full relating of all these items for you, but he has asked me not to do so. I think in the interest of hearing him rather than hearing about him we'll cut this rather short.

Professor Skinner has been interested in the field of psychology for a great many years, having joined the Psychology Department of the University of Minnesota in 1936, remaining there until 1945, having worked during the war in industry, having been a member of the Department of Psychology at Indiana University, and in the fall of 1947 having been appointed to Harvard University as William James Lecturer. He joined the Department permanently in 1948. His major field of interest is the experimental analysis of behavior--a field in which he has done a great deal of work--both for education and in industry. He is a member of many distinguished societies in the field of psychology and has been given many honors and recognitions in that field.

In 1953, Professor Skinner became actively interested in the possibility of applying in education some of the things which had been learned in the laboratories about the nature of learning and the ways of reinforcing it. He has often been called the pioneer of the teaching machine in this decade. It's a great pleasure for us and a great honor to hear Professor Skinner and his thinking on this important subject. Professor Skinner:

Teaching Machines

B. F. Skinner,
Professor of Psychology,
Harvard University

Thank you, Mr. Johnson. As the Chairman has said, teaching machines are an example of the practical application of basic research. I think the promise which they hold is exciting, and I know that you, because of your own interests, might be particularly interested in hearing about the possibilities of their use and the extent to which they can solve some of these pressing problems. As someone in the middle between the basic science and the technology, I think it would be more suitable for me, and, I hope more useful to you, if I try to convey to you the kind of basic thinking which lies behind a technology of education in this sense. The teaching machines are a small example.

The experimental analysis of behavior, I think without any doubt, has been extraordinarily productive during the past twenty or thirty years, particularly in the past decade. We have learned a great deal about the conditions under which organisms behave and why they behave. Most of this work has been done in laboratories under fairly rigorous control. But there are a few of us who have been hardy enough to speculate on applications elsewhere--in areas beyond that or collateral with that in education. The extent to which this kind of rigorous laboratory analysis now permits us to examine what is going on under much less rigorous conditions is increasing steadily. In economics, government, psychotherapy, as well as in education, we are today in a position to examine what is going on and to throw some light on it of a sort which is quite different from the general wisdom which comes from the inspection of such a field alone.

In the case of education, if you look at what is going on and try to interpret it in the light of laboratory research, some things do, I think, emerge rather clearly. I don't need to remind you of the early history of education where techniques were frankly primitive, coercive, and aversive. There have been periods when the viciousness of the teacher with a rod or cane has become legendary. It was only recently that any serious effort was made to depart from a general pattern in which the student was required to learn or else. Now, we haven't gone as far as we would like. We've given up corporal punishment, but we've been very ingenious in thinking of alternatives--subtle coercion, subtle punishments, criticism, ridicule, failure, and so on. It is still I think generally true, in spite of the heroic efforts of educators and philosophers of education, that the student in our schools today is doing what he is doing, not because he wants

to, but because he doesn't dare do anything else. There are a few basic tests of this: if you want to know whether the students are in a class because they want to be there, dismiss the class and see whether they leave. Or, if you want to know whether work is pleasurable, something that is done for positive reasons, notice whether the teacher uses extra work as punishment. Extra work should be a reward if it's as delightful as schools often claim it is.

Now, this pattern is a dangerous one! Everyone is aware of that, and everyone is aware of the by-products. From laboratory research we can now specify these quite clearly. The major patterns of reaction to aversive control are easily spotted in education. Education has its own word for a form of escape from control--truancy and the truant officers who enforce attendance, and so on. Other forms of escape which are more serious consist of not paying attention or forgetting the whole thing as soon as possible. There is also a kind of reaction which is a counter aggression--an attack upon the school system--vandalism is a problem in all large cities--vandalism against school property. There is, of course, a more severe form of vandalism where people who are products of the school system go out, become voters, and refuse to support efforts to extend education.

Apathy is another standard laboratory product of this kind of control. The stubborn, resentful, sullen student who is sometimes a product of our system is familiar, I am sure to all of you.

Now, we all want to get away from that, but the use of the alternative methods has never been too successful. We must admit that where teachers have given up the threatening kind of control they have become uneasy about whether they have any control at all. They become afraid of students, afraid to ask too much from them, and so on; and the general level of control drops. This is because the positive kind of learning has not been fully exploited. At present we know a great deal about positive rewards or reinforcements--to use a technical term--and how to arrange these reinforcements so that a high level of active, productive behavior results. In the laboratory, we can demonstrate this quite clearly. We can gain an extraordinary degree of control over an organism whether it's a rat, a pigeon, a chimpanzee, or, in many cases, the human subject. There we have precise control, and we can see how these things work. The trick then is to make sure they also work under the exigencies of a school situation.

The teaching machines are simply devices which were designed to make it possible to relate behavior to its affective consequences in a way which generates not only the production of new forms of be-

havior but a high level of interest or enthusiasm. This whole question comes down to what we call, technically, the contingencies of reinforcement. How are the consequences of what one does related to what one does? If they are remote, as remote as the ultimate advantages of an education, they won't work at all. The student may want to become a doctor or an engineer or something of that sort but that gives him precious little help when he is faced with a page of a text book in his room at night and must read it and remember it. Our system of grades, marks, prizes, honors, and so on are efforts to use positive reinforcements, but they are, in some sense, rather spurious and are not related to behavior in a way which generates a high level of activity.

I can give you an example of the importance of contingencies of reinforcement by starting with something, which, I'm rather afraid, is rather far from the interest some of you have. Take the question of the timing of behavior. There are fields of sports, music, the choice of one's avocation, one's effectiveness in industry working with equipment and machines, and so on; in which a good deal depends upon a fine sense of timing. As in the case of music, the whole problem is one of rhythm. Now, you can either assume that people differ widely--some have a good sense of rhythm and some don't--and that's the end of it, or you can argue, as we can now argue on the basis of our laboratory research, that rhythm is, indeed, something which is shaped--which is built up in behavior by very sensitive contingencies of reinforcement. If you want an organism to pace at a given rate, you arrange a situation in which only precisely paced responses pay off. Or, if you want an organism to beat out a particular pattern, then that pattern must be precisely reinforced and other patterns rejected.

Now, it's impossible to do this simply through a personal interchange. You can say, "Yes, that was a pretty good example," or "No, that wasn't quite it." But the precision needed to build really effective rhythmic behavior requires some equipment. The first slide shows you a device which we are now using to test this and lets you see to what extent we can build a good behavior in this particular field. This is a device which simply presents to the student a particular pattern. This machine raps out a rhythm--whether it be a steady beat or a particular pattern. The student taps a key against a rubber soundless background; his task is simply to tap in unison or in alternation with the machine. The machine, first of all, allows a rather generous leeway. He can either be a little ahead or a little behind the tap. As he taps in rhythm, a spot of light hops across the field in back indicating his success.

Now musicians who feel they have a good sense of rhythm are

often surprised to discover how wide the tolerances must be if they are to be very successful. But they also quickly discover that the machine sharpens up their sense of rhythm. I don't believe this world is going to survive or perish because of the existence of rhythmic behavior in the population; however, it is not an innate ability--it is something the environment has a possibility of shaping up in an individual. In a frame we can arrange the contingencies which will lead to a fine sense of rhythm.

There are apparatuses, devices, musical instruments, and so on which maintain these contingencies of reinforcement, as we call them, but they don't program it. They don't lead the student into a final, perfect performance. Some people get there by accident, or otherwise, and are good rhythmic performers, but with a device of this sort everyone could move into that happy state.

Another device is concerned with the ways in which we react to the environment. This is still not a school subject; but if you will pardon me, I would like to describe it. The next slide shows a type of device which is based upon work--work with pigeons, believe it or not, which teaches pigeons to match colors, shapes, sizes, three dimensional forms, and so on. Here again we tend to assume that, let us say, a sense of the third dimension is something which varies very widely in the population. We can give tests for it. If we have a particular job and we want someone who has a fine sense of the third dimension, we test a lot of people and select the one who shows competence in this field. That's a very wasteful technique, and it can be shown that you can build these abilities. Even in an organism, like a pigeon, you can build a fine sense of color discrimination. Some people do get it out of the accidental contingencies of life, but with a device of this sort everyone could have it.

The next slide shows a similar piece of equipment with all of the controlling circuits which are used. This is a lot of programming equipment here. When the student presses these panels, something appears in the upper panel. He pushes it--thereby indicating that he has looked at it. Materials then appear in the panels below, and he must point or push the corresponding pattern. We've used this with retarded children with I.Q.'s as low as 40 or 50. You can begin to make progress provided you program the thing very easily. So through a series of easy steps the student becomes competent.

Now, if devices such as these two were very widely available, our children would become much more effective; that is, they would be much better able to use their own bodies, and they would be much more sensitive to the properties of nature. We can't assert that

as "proved" now, but we can certainly assert that the conditions which we know are necessary for that behavior are not in existence at the present time. Our schools and our daily lives are impoverished so far as these fundamental contingencies of reinforcement are concerned. Only some kinds of machines will make it possible for the child to develop adequate senses and adequate behavior in these areas. Playing with colored devices, toys, and so on, of course, is helpful, but it hasn't the precision which is so effective in bringing about these very important changes in behavior.

I don't think as school people you care too much about the building up of these basic abilities. You are interested in subject matters and that is understandable, but the same techniques apply there. If you want to build verbal behavior, you can accept it as behavior and use the same approach. Instead of trying to teach something called "an ability to read," you teach those behaviors which are said to "show the ability to read."

A person who can read differs from a person who cannot in objective, observable ways. To say that one possesses an ability which the other lacks is a very inadequate way to represent these differences. Unfortunately, it doesn't dictate ways of making the difference effective or of bringing the differences about. But if you once analyze what is happening in reading, how many different kinds of things a person who can read can do, then you have an immediate, positive object or goal and you can design devices and program contingencies of reinforcement which will produce it. This machine can teach reading, it can teach matching letters simply as forms, matching words as forms, relating words to pictured objects, and so on. That's the beginning of what you call an ability to read, but it is an analyzable step in terms of the repertoire--the behavior repertoire--which distinguishes the person who knows how to read.

If you want to move on to subjects which are of closer interest to you, you have to go beyond a machine which merely points to the behavior at issue.

The next machine shows a type of device in which the child is actually composing an answer. Some sort of material appears in the open windows, and the child completes it. There are letters or numbers missing. The child completes the material by moving sliders. Now, you can do this with a modified typewriter much more conveniently. Dr. Amar Moore at Yale has been working in modifications with typewriters as teaching machines of this sort. We have one in our project at Harvard; Dr. Matthew Israel constructed it. The child reads something that is not quite complete, such as an equation, a sentence, or

a word, and completes it by adding letters, numbers, or signs. Once this has been done, the child tests the material--in this case by turning a crank--and the machine senses the settings. If they are correct, the machine moves on to the next frame. If it's wrong, the sliders go back, and the child must compose another try. This has one advantage in that the machine can tell him if his answer is incorrect but fails to tell him what is right. It's rather an expensive machine. It is usually possible very early in the grade school level to go from this machine to a type of device in which the child writes out or typewrites an answer and compares it with a revealed answer.

The next machine in the next slide shows an early type of device I used for three years in teaching my course at Harvard and Radcliffe. The student sees the material in a window--a sentence usually to be completed by filling in a blank or two. He writes in a response in the window at the right, operates the machine which covers his response with a transparent cover, and then uncovers the correct response. If he is right, he moves onto the next; if he is wrong, he can get that item again. It comes back to him since the machine goes through a set of frames again and again until each frame is correctly answered. The device of bringing back the missed item proved not to be very important because in good programming you can reduce the number of wrong items almost to the vanishing point. A somewhat simpler machine now seems desirable because of this improvement in the art of programming.

The next slide shows a self-instruction room at Harvard. Because the enrollment in my course is up this year, we've had to rip the booths out and make them smaller. We have twenty where we had ten before. It's rather crowded, but students still are glad to settle for this way of studying because of its extraordinary efficiency.

The machine we are using this year is shown in the next slide. I'll mention features of it later. It again presents material in the window at the left; the student writes at the right and operates the machine to cover what he has written and to uncover the correct response.

This kind of machine is effective. There is no doubt of the enormous efficiency of instruction with this type of device. The experiment which Dr. Allen Calvin did at Roanoke, Virginia, last spring indicates that at the 8th or 9th grade level a subject matter can be covered in about one-half the time compared with the usual classroom type of presentation. Incidentally, they have just tested attention of those students--they were all 8th grade students in a five-track system who went through 9th grade algebra in one term. They tested only twenty-five of them--all they could get out

of a group of thirty-four or five--and found on a re-taking of the final examination that the retention was ninety-five per cent. There is no question here of any special weakness in machine teaching from the point of view of retention.

Fifty per cent savings in time will, of course, only apply where the present system is relatively ineffective. In industrial education where conditions are already good--where the motivation of the student is high--the savings will be considerably less. I've seen some figures lately of a large corporation which has been doing this, and I would estimate that instruction with this technique as against standard instruction effects a saving of about twenty-five per cent, rather than fifty per cent. And this, of course, means a savings for this company of five or ten million dollars a year because they release time for instruction.

Now, why is this the case? One thing you see as soon as you see a group of students studying this way is their enormous high level of interest. They are active; they don't force themselves to work; there is no feeling of effort because the programs are so designed that almost every step is correctly taken. Some people may feel this is actually a paradox: you can't be learning if you knew it all along. But you do learn a great deal. In our class right now a student is wrong on a given item in a set of frames only about once out of every twenty times. We'd like to get it down to zero.

That high level of motivation is one of the results of making immediate knowledge of results available. It can only be done with devices because the teacher does not have the time to be in contact with the individual student in order to arrange the same consequences. Each student goes at his own rate, and this is an enormous savings. The good student is not held back; the slow student is not forced to go too fast. Many people have felt sorry for the good student and have taken measures to give him a chance to move at his own rate. I feel sorrier for the slow student, because there is no indication that the slow student is necessarily unintelligent. Many intelligent people--many productive people--work very slowly. But what began as a very small difference in speed soon turns out to be a difference in intelligence or comprehension because a student who is forced to go a little too fast the first day is not quite successful and, therefore, not successful the second day. His short comings grow, and eventually he gives the whole thing up as a bad job. Yet, among those students there might very well have been many who would have gone on and done fine things. No one knows how much we pay for a system where a whole class is forced to move at something like the middle-of-the-road rate. It holds the good student back; it may very well destroy the possible achievement of the more slowly-moving student.

Everyone is aware of great differences of speed of reading, and this doesn't correlate very well with intelligence. Why should we not expect that the differences of comparable nature affect the instructional process outside the speed of reading?

This kind of success comes from the fact that--and this, I think, is the main contribution of teaching machines to date--it forces the person who writes the program to analyze what he is doing and not to leave out any essential steps. If you take subject matter and assume the responsibility of writing item by item a program so that the student is usually right, you will discover how many gaps there are in an ordinary text book and how much the teacher needs to come in to remedy the trouble which arises from a broken program. You start with perhaps ten frames to cover a small area, and before you know it, you have thirty frames because you discover that you have left out many important steps. The fact that there is an inanimate machine which is going to come between you and the student and there is no teacher around to make up for your defects as a programmer presents a great challenge, and it has led us slowly and rather awkwardly to discover some of the art and technique of programming.

Now, this aspect of it--the verbal subject matter--is a good area in which to raise the point I am making here. With equipment of this sort we are now able to look again at what we mean by some of our basic instructional processes: What is teaching? What is instruction? What is learning? We used to believe, and many people still do, that the teacher communicates with the student and imparts information. We looked on this as a transmission problem. Present day communication engineers have added great prestige to this notion of transmission. It's as if the teacher were a source and the student received a stream of information and stored it. This is not true! We have had evidence to the contrary for so many years. When you tell a student something, he doesn't, therefore, know it. But we refuse to believe that, and we go on telling in the belief that we are communicating. We know that is not the case! The notion of communication, of improving channel capacity, and so on is pretty irrelevant to the whole problem of instruction.

The student must do something, but what? Well, the older version was that he must associate. Present two things together, and he connects them together somehow in his mind. Many machines which have been called "teaching machines" are simply ways of presenting things together--a picture and sound stream or something of this sort. But association, in that sense, is an invisible and probably non-existent process. What the student must do is something objective and controllable. He must make responses of some kind. The machines are designed to encourage the student to engage

every moment in active responding. The student cannot stop working on a machine; if he stops, the whole thing stops; very much unlike a lecture like this or a television program.

What is the process of instruction, then, if this is the case? Let me take two short examples to get this point exemplified. I can't hope to cover all the details, but I want to suggest to you that the machines have stimulated us to look again at the process of instruction and communication.

Suppose you are learning a poem. You read it through. You are presenting to yourself in a sense, but this will not teach you the poem. It is quite possible if you read a poem again and again and did nothing else, you'd never learn it. Merely having the parts of the poem occur to you in a joint presentation is not enough. What anyone does who studies a poem is to look at a line, turn, attempt to say it, look back, and pick up a little additional information if you can't say it, and then look back and check to make sure that what you said was, indeed, what the poem said, and so on. This whole process of looking, turning away, looking back for help, turning away, completing the sentence or line, looking back to confirm it--you see there is a very rapid interchange here involving several things. The original presentation, the presentation of little bits of help, if you need them, and confirmation--all of this is what a teaching machine does! That's all a teaching machine does at that particular time! You can teach a child a poem if you want to demonstrate this machine. Put a poem on a blackboard clearly spelled, erase a few letters, and say, "Read it!" He reads it aloud. Then have him turn away while you take out more letters and have him turn around and read it again. He can do this because he has just read it. He wouldn't have been able to do it the first time with this degree of erasure, but he can now. If you take out more letters again and, perhaps, for the last step there is no poem there at all, he can still "read it." Now, this is a very inefficient way of reducing the text and allowing the student to take over on his own the mission of the verbal behavior of the poem. It is a good example of what we call vanishing a response to prompt. A machine can do it skillfully, but this is a way you can do it if you want to try it out. It is a kind of instruction, not a very important one but a useful one.

What happens when a student learns the name of a pictured object from a labeled picture? You say, "Well, he sees there's a picture and here's the label and that tells him what the name of that object is or what that word refers to." And, yet, no such thing happens. You must, in this case, look at the picture and read the label; but if the label stays there forever, you've learned nothing. The label

must also be vanished to some extent, and you might look at a half-dozen of these and then turn away or cover the labels; if you can respond, you do it; if you can't you peek.

All of this sort of thing is done also by teaching machines in an effective way. This is instruction. This is learning. In many cases, only devices will arrange conditions in the most fruitful way. A good teacher does this; a good tutor does it; but the whole practical problem of finding individual teachers to spend all their time with individual students in a very grave one. Some kinds of equipment can solve some of the problems for us.

Once you have tried to teach subject matter in this way, you realize immediately the need for defining what you want to do in behavioral terms. What is first year physics? What does a person who has gone through a physics course have which a person who hasn't gone through it doesn't have? What kinds of behavior will he now demonstrate? What things can he say? What things can he do? If you analyze physics that way, immediately you are directed towards an effective program. You can construct a sequence of events leading from ignorance to competence. But until you have answered that question--what do you want the student to do--you are not going to get very far.

The program is the heart of the whole matter, and machines can be dispensed with in some cases. There is a movement on now to try to get along with programmed work books. This uses some of the points I have been raising here, but it would be a great shame if we settled for that because there are many other aspects of the instructional program which are not covered by a simple, quick check-up on the individual answer and the possibility of moving at one's own rate. The machines I have shown you were very far from the elaborate electronic classroom you sometimes visualize. Some of them even use computers. It's assumed that the machines are going to follow the student through the labyrinths of his thinking process. This is based upon standard instructional process--a situation such as the classroom where students often go wrong and must be brought back to the correct path by a teacher who examines the individual's misconceptions and clears them up. But this is not, necessarily, involved in the process of instruction. It is quite possible to learn without making errors, and a good program or a good teacher should not need to do this constant correction of misunderstanding. Theoretically, there should be no need whatsoever for the misunderstandings to arise in the first place. The whole question of whether you have to learn from errors has a long history; it goes back to early experiments in learning--trial-and-error learning--it is a principle we now never appeal to in psychology. It is not necessary that you try to eliminate errors. If you don't need to try, if the instruc-

tional program directs you to make the correct response, there are no errors; nevertheless, knowledge is acquired. Mr. Herbert Terrace, a graduate student in our department, has recently shown that pigeons can learn to make very high discriminations between colors or between patterns of lines without ever making a mistake. He starts with a discrimination of two colors which are very far apart, and the pigeon responds to one and not the other, and then he brings the colors closer and closer together on a given schedule. Eventually, the pigeon is making a very difficult discrimination, and he has, never in his life, responded to the wrong number of the pair. You can work at this in such ways that the fine discrimination is transferred to new properties of extraordinary subtleties.

Multiple choice teaching machines make this mistake. They are based on older theories of the consideration of the items in an array and the elimination of error leaving the right response. You learn nothing from making a mistake except not to make it again--that doesn't mean you learn what to do instead. Although various procedures have been worked out for using multiple choice machines, they are not based upon a modern conception of the learning process.

The devices which are in existence today are undoubtedly early, as we will see eventually, and are awkward efforts to bring into education some of the capital equipment needed. We can now demonstrate that these machines are highly advantageous in the learning process.

Don't identify the machines with the technology behind them. The technology is, as perhaps some of these examples I've mentioned this morning suggest, much more varied. Technology offers many more possibilities than existing machines have attempted to realize. We are growing in our knowledge of the human organism and its capabilities. The arrangement of conditions which will permit the individual organism to develop itself fully will certainly require instrumentation of an extra-ordinary variety.

Merely putting across a verbal repertoire, such as a knowledge of physics or of French or knowing how to read, is only a part of this. Many people have felt that this would restrict the individual and rob him of the chance to think. The argument back of multiple choice teaching machines is that these machines stimulate thinking. Well, actually, you can teach thinking, but you have to do it directly and not by inevitably sabotaging the teaching of subject matter.

Many present methods in education have directed themselves towards stimulating thought and, in doing so, have done a bad job in putting across subject matter. These two are separate assignments

and must be dealt with separately. The machines which will teach thinking are just coming into being, and I'm sure that here again these early models will seem quite awkward but will eventually be adapted to the purpose. But you can analyze various kinds of self-management that a student engages in while working his way through a problem and coming up with a response which education has not built into him as a part of a standard repertoire.

Let me just take one example of the kind of analysis that is involved here. One of the things involved in thinking is attending to or noticing details. In the old days, when you could punish a student in a perfectly clear cut way, the student could be made to pay attention--at least could be made to look at a book, read a book, or listen to someone talking. When that practice was given up, people turned instead to attracting attention, to getting the student to notice something without being coerced to do so. Many of the audio-visual aids that have been devised are falling back on other techniques to attract attention: you must get the student to look at something in order to do something effective about it.

Now, that method is actually in conflict with what ought to be done. You don't necessarily want a student who is easily attracted to interesting things but someone who will look at something that is not interesting on the face of it because after looking, something interesting happens. You want to teach the student to pay attention, not merely to attract his attention. Devices which are arranged to teach paying attention will probably make very little use of the technique of attracting attention.

If I had time, I could go into other ways in which we can approach the problem of thinking. I want to be sure that you don't conclude that merely putting across knowledge is the only object of devices under consideration.

Regarding the present status of the teaching machine, I'm sure that you will be interested in that, and I'm sure that the later speakers this morning will get around to more of that; there is undoubtedly a threat at the moment from commercial involvements. Many people see in teaching machines an important industry--which is probably true. Publishers are picking up programed text books. The figures that some of them have come up with by way of market analysis are certainly impressive. The teaching machine is in the market place now, and the market place will have to follow its own devious ways, I suppose. You can buy bad machines today! You can buy bad programs! I don't know how anyone can do anything about this except to urge caution and to suggest that there are various ways of evaluating and standardizing these things. I hope this will

move rapidly in the direction of standardization and some standard of testing and pre-testing. The commercial aspect of this could do great damage. On the other hand, it's the kind of thing that can only develop, in the American scheme of things--through some kind of commercial operation. It's a difficult course to steer, but I think it is the only way in which we can make the most effective use of this knowledge in a fairly short time.

Back of it all there is a broader technology which is not represented in any particular teaching machine, and my main concern this morning has been to suggest to you some of the ramifications of that technology and to suggest to you that we are at the very beginning of an elaborate development of equipment. This equipment will make it possible to bring into the practical situation of the school some of what we are learning under easier, simpler, and more rigorous conditions in the laboratory.

Thank you.

Herbert Johnson: Thank you, Professor Skinner. Our second speaker is Professor McClellan of Teachers College, and in the interest of saving time I will condense the remarks we will make about him. He is a native of Texas and educated at the University of Texas with his graduate degrees from the university of illinois. He has been a teacher in a Texas high school, a high school in Illinois, a teacher at Florida State University, and, since 1955, a Professor at Teachers College, Columbia University, in the field of Educational Philosophy. He has a long list of distinctions and many contributions to the literature of education which we will fore-go at this time.

I asked Professor McClellan how he developed his interest in the teaching machine. He said it arose from the questions raised by students in his classes; particularly a student who, about three years ago, asked his opinion about this new development which was being widely discussed. In the effort to ascertain what the possibilities were of this new thought, he began to explore the subject; his interest led from step to step until he finally is a member of the Board of Directors of the Center for Programed Instruction -- an organization in New York City which is working in this field. It is a pleasure for us, then, to hear from Prof. James Edward McClellan.

Prof. James E. McClellan: When Prof. McKenna first asked me to take on this assignment, I thought that I should restrict my remarks more or less to speaking to some of the practical administrative problems that we face as we try to utilize the kind of theoretical developments that Prof. Skinner has mentioned. In trying to work through this, however, I discovered that I couldn't do this well--first of all, because I don't know enough about the administrative problems, and secondly, because doing this would fail to do the kind of things I think ought to be done here as we consider the theoretical problems on a broader basis. So I'm going to talk philosophy, and I'm going to do it with a bad program of teaching. What I'm going to try to say here skips a lot of the frames that ought to be included if you're going to get what I'm going to say, but I'm going to go through it and put enormous demands on your attention. You must pay attention because I'm not going to try to attract it. I can just say this: after a week or so you will receive a copy of this manuscript; things you didn't pick up can be found by peeking back in; and you can construct for yourself a more efficient program, having gotten this cue now and the manuscript later.

Automated Education: A Philosophical Approach

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In 1954 Prof. Skinner published a forthright manifesto asserting that psychological principles of learning could and should effect a revolution in our practices of schooling. In language unfamiliar to the practical schoolman, he showed not only why schooling was so ineffective but also how it could occur at all. It is likely that some readers of his article hadn't the faintest notion what he meant by saying "that efficient mathematical behavior...requires something of the order of 25,000 contingencies...Perhaps 50,000 contingencies is a more conservative estimate." But no reader could fail to understand the practical import of his message: "We are on the threshold of an exciting and revolutionary period, in which the scientific study of man will be put to work in man's best interest. Education must play its part. It must accept the fact that a sweeping revision of educational practices is possible and inevitable."

Let it be noted that I am not going to deny either of Prof. Skinner's main theses in that article: neither that sweeping revisions have to be made in schools, nor that the findings from the psychological laboratories can and will provide the brooms with which to do our sweeping. I don't consider this session a debate on matters that should be obvious to anyone who looks at the evidence. Transforming the obiter dictum of an earlier educator and psychologist, we may say: "Anything that can be taught can be programed; if it can be programed, it can be automated." If we take "teaching" in its most obvious sense, meaning "giving direct instruction," that dictum is, I think, true, though in other senses of "teaching," it isn't true. It is also true, so true it shouldn't even require mention, that whatever can be automated is better done by machines than by people. And by "better" I mean not only "more efficiently," I mean also with greater moral justification for the use of distinctively human resources and talents.

But to return to that same article of 1954, Prof. Skinner there threw out, almost as a stage aside, some remarks about philosophies of education. He suggested what we may call the sour grapes conception of philosophy of education. It goes like this. Since the teacher lacks any genuine control over what her pupils learn, she rationalizes that such learnings are not very important anyway; "she spends as little time as possible on drill subjects and eagerly subscribes to philosophies of education which emphasize material of greater inherent interest...Eventually weakness of technique emerges in the guise of a reformulation of the aims of education. Skills are minimized in

favor of vague achievements--educating for democracy, educating the whole child, educating for life, and so on...unfortunately, these philosophies do not suggest improvement in technique."

Leaving aside certain rather derogatory intimations in this passage, I think Prof. Skinner, as is his wont, has recognized the very central feature of the matter he has turned his mind to, in this case that there is an inherent connection between the technical possibilities and limitations of any enterprise and the philosophy of that enterprise, where by 'philosophy,' I mean the basic rationale by which the nature, purpose, and context of the enterprise is explained. This is as true of industry and government as it is of education.

I might add a word of defense, however, both for the fox and the philosophers of education. Was old Reynard to spend the rest of his life in complete self-abasement because his vision exceeded his grasp? Would it have been better for Prof. Skinner's teacher, a poor defenseless female at that, to have accepted specific and clear aims that she lacked the technique to achieve? Were the philosophers guilty of any great sin in telling her that even if she wasn't teaching very much, she may be doing something even more important, e.g. building democratic attitudes? Is there any harm in a small, pious deception that make the ineffectiveness found in most classrooms a little less dreary than it would be if faced nakedly and hopelessly?

But there is a positive side also, and to that we now must turn. When there are technical resources available in our culture by means of which we can overcome the ineffectiveness of ordinary instruction, then it is basically immoral to cover deficiencies with platitudes. Today we need a new philosophy of education to express meanings and purposes that take account of the most advanced technical resources at our command.

I may suggest somewhat tentatively that the relative slowness for the introduction of automated teaching in schools (as compared with the Defense Department, industry, even civil government) comes from a philosophical failure--i.e. a failure to see the new techniques in relation to the meaning, purpose, and context of the public schools in American life. To change this failure into success will require thought and effort from many people. This morning I can indicate only some of the conceptions that will have to be changed, mostly by the teaching profession, but partly by those who are contributing the newer techniques. The matters I mention are not coordinate, nor do I yet see a system of thought for the new education. But a new philosophy would have to include at least conceptions of the nature of thought, of subject matter, and of unity in a curriculum.

1. A conception of thinking. The philosophies deprecated by Prof. Skinner did have a liberal and humane conception of thinking. It was based, negatively, on a rejection of faculty psychology and, positively, on a full acceptance of the view that man is an adaptive social organism, continuous with the rest of the biological universe. Thinking is, on this view, precisely the ability to adapt successfully, i. e. to solve the problems in one's environment. Let me call this the problem-solving conception of thought. You see, do you not, how well this conception fits in a school that has become too civilized to use aversive reinforcement systematically enough and brutally enough to be effective in teaching a great deal of material to a great many youngsters by a quite heterogeneous body of teachers. You can see also that this conception had a more viable connection with the scientific world outlook than did the muscle conception of mind it replaced. The experimental evidence which showed the absence of transfer in pure skills of memorization, and the evidence which showed how seldom it occurred that facts learned in isolation from any problem situation would actually be used when needed, and all the other carefully edited results of not-too-careful research were used to deny that the mind is a muscle and that exercising particular mental skills makes one's mind a more powerful muscle.

The problem-solving conception of thought is radically different from its predecessors. Unlike the muscle conception (or Herbart's container conception or Locke's tabula rasa conception, etc.) the problem-solving conception is not a metaphor. Its basis lies in unquestionable scientific fact: man is a bio-social animal whose mental activity has its place in the natural scheme of organic adaptation. Our task is not that of replacing the problem-solving conception of thinking by something else; it's a matter of relating it to other theories so that we may get a mental grasp (I'm tempted to say visual-mental grasp) of the details, the intricacies of learning of the sort we want to occur in schools. In short, I'm asserting that a fully effective (and guilt-free) use of teaching machines is impossible until we who are educators have, first, a clear sense of how and why (the two are the same) these machines teach and, second, a sense of education in which we can use this teaching in a way that is acceptable to our morality as educators.

Prof. Skinner will, I think, agree with me here. In his most impressive book, Verbal Behavior, he writes "A practical consequence is that a scientific account [of thinking] implies technology. There is no reason why methods of thinking and the teaching of thinking cannot be analyzed and made more effective." (p. 449) Having said this, however, he drops it and turns quite significantly to "more immediate theoretical issues."

I do not believe that the same language and same theoretical

models will work both for the theoretical analysis of thinking on one hand and the practical improvement of the thinking in schools on the other. This claim, if true, will explain also why the problem-solving conception of thought was ineffective in improving teaching practice: for the purpose of the theorist, it is important to seek a single, unified answer to the question: What is thinking? For the practical educator, it is necessary to ask and answer a different question, viz: How is thinking in history different from thinking in science, science from thinking in mathematics, all these different from the thinking that goes on in learning a new language, or responding to poetry and paintings, how are these in turn different from decision-making in the practical affairs of life?

Prof. Skinner has been concerned to show that all thinking is behavior. Personally, if one sense of 'thinking' is meant, I find his arguments and evidence completely convincing. But between the theoretical analysis on one hand, and the improvement practice on the other, there is still an enormous gulf. Prof. Skinner himself puts it this way:

"The verbal processes of logical and scientific thought deserve and require a more precise analysis than they have received. One of the ultimate accomplishments of a science of verbal behavior may be an empirical logic, or a descriptive...epistemology, the terms and practices of which will be adapted to human behavior as a subject matter."

The program of study suggested by Prof. Skinner is fascinating, but its promise is other than it might appear. To explain why, I must talk a little philosophy. Suppose we teach a student a bit of information, say, that a molecule of water contains 2 atoms of hydrogen and 1 atom of oxygen. We ask him first, for the composition of water and he answers correctly. We ask him, second, why he answered the first question by responding "2 atoms of hydrogen and 1 of oxygen." Now he could give two quite different sorts of answers to this second question. A: He could refer to the reinforcement for that response in the teaching program he had been through. B: He could refer to the molecular theory of substances and show how that theory accounts for certain chemical phenomena, especially electrolytic decomposition of water and the presence of water after the burning of hydrocarbons.

These two answers correspond to the two interpretations of the original question. A interprets the question "why did you say H₂O?" to mean: "What caused you to answer thusly?" B interprets the question to mean: "What reasons can you give for your answer?"

Both these are perfectly legitimate, but educators believe, rightly I think, that only if the second, B, is included is there a

sufficient justification for teaching of the sort we try to do in schools. In industry and in the military establishments, that isn't necessarily the case. There the student's teachers are (or may be) concerned only that he make the proper response. If the light turns red, then pull this switch, check the power tube, if the power tube is good, then....etc. His teacher, or the student himself, may sufficiently explain why he does it by referring to the sequences of teaching frames that caused him to do it so.

But this won't do at all for teachers. Or better, if it will do, then we shall have to give up entirely our usual ways of justifying the educational enterprise. In a mostly intuitive way, we feel that the true glory of American education lies in its persistent efforts, however feeble or effective they may have been, to give all citizens of our country reasoned grounds for thinking as they do.

Does this mean we have to renounce any use of what has been learned about the causes of behavior, where behavior includes thinking as one of its modes? Not at all. On the contrary, as I shall argue in a minute or two, the new technology of teaching can mean that we finally have the resources to transform the noble but usually ineffective efforts into rather routine successes. But it does mean that we must understand and justify our behavior as teachers not by reference to reinforcement theory of learning, but by reference to the reasons we give students for thinking as we teach them to think.

Let me be a bit more precise still: the word 'thinking' is itself ambiguous. There is one sense in which 'think' and 'believe' are nearly synonymous, another sense in which are not. If we are discussing, say, the effectiveness of teaching machines and someone asks: "What do you think?" This would be just the same as asking: "What is your belief?" But there are other senses in which these two words differ: It makes perfectly good sense to ask, "What are you thinking right now?" But it is quite strange to ask, "What are you believing right now?" Again we can imagine looking at a group of sleeping children and saying: "That child believes Columbus discovered America." But it would be stupid to say, "That child is thinking that Columbus discovered America."

Following Prof. Skinner, I want to use the word "thinking" so that it makes perfect sense to follow this syllogism:

All behavior is caused.
Thinking is behavior.
Thinking is caused.

I use the term 'believe' so that whenever one asks: "Why do you believe so-and-so?" he is asking for your reasons, not the causes of your thinking. The causes for your thinking must be

explained in terms of the reinforcement we received from this behavior, whether this behavior was overt and reinforced from outside or covert and reinforced by our own responses. About beliefs, however, we do not ask what causes them but whether they are true or false, valid or invalid, or, as Dewey would put it, warranted or unwarranted. These characteristics of belief are explained in terms of the reasons we can give for holding them.

The distinction between causes for thinking and reasons for belief gives us a very important perspective on the problem-solving theory of thinking. One reason to believe that what one has learned is true is that acting on what has been learned leads to a successful solution of one's problems. In fact, this is a uniquely meaningful reason so to believe. Suppose I am the commander of a submarine that is stuck on the bottom. We are short of air. I rig up a tank for the electrolysis of sea water and, sure enough, oxygen is released in our crowded quarters. I have a different sense of what "water is H_2O " means when my lungs begin to function better. (If someone strikes a match and the hydrogen explodes, I might sense its meaning, however briefly, even more significantly.) There is a sense of 'knowing' such that I never really knew why I believed water is H_2O until I had used this information in some practical way. It is not, let us be clear, that such an experience gives me better reasons than I had before, just that it gives me a uniquely different reason.

Without going into all the pros and cons of it, let me say that I do not believe that this pragmatic conception of reason for belief is applicable to very much, if any, of the teaching we have to do in schools. And its inapplicability holds whether we use the new technology of programing in our teaching or do not use it. The only difference is this: when we don't program in the fully developed sense, we have so little control over what is actually learned, that we can fool ourselves that we are giving students pragmatic reasons for believing what we teach them. When we do use fully programed methods, we can't engage in that kind of self-deception. Facing the full import of programing, if we hold strictly to the problem-solving sense of reasons for belief, we seem to be confronted with two equally unpalatable alternatives: either we use the new technology and reduce our teaching merely to causing our students to behave robot-fashion, giving pre-determined responses to pre-determined stimuli, or else we purge the curriculum of everything that cannot be taught through problem-solving by the student. At least the latter alternative would enable us to say that the student had learned to think, that is, had gained reasons for believing that what he had been taught was true.

To resolve that dilemma, we need a different conception of what constitutes a reason for belief. For that we must turn to a second

but closely related theoretical matter, the theory of subject matter.

2. A conception of subject matter. There should be no need to recall our basic morality of subject matter here. At least since 1918, when the Seven Cardinal Principles of Secondary Education were promulgated, we have held that our basic task is improving the quality of living and that subject matter is properly to be regarded as sets of intellectual resources to be used by the student in meeting his real life problems. The only moral justification for teaching anything, on this view, is that the material taught will make a substantial contribution to improving the life of the student.

We have argued among ourselves at great length about the best way of organizing a curriculum that will satisfy this basic morality. Some have said that the curriculum must be organized around the immediate problems, or felt needs, of youngsters at each stage of development. These thinkers have concentrated their attention on the habits of using what is learned; they have taken to heart Dewey's maxim that education is not preparation for life, but life itself. Others have held that we could look ahead into adult life and see what knowledge would be useful there, and in turn organize our present teaching to make sure that the adult would have proper intellectual resources in his repertoire, as it were, when these resources were needed. Prof. Stratemeyer and her associates have a most ingenious compromise between these two conceptions in the idea of persistent life intentions.

There can really be no questioning of this morality, and we must return to its implications later. But the thinkers who develop curriculum organization in response to these moral demands did not have a theory of subject matter, by which I mean precisely a systematic set of answers to the questions I raised earlier: How is thinking in history different from thinking in science, from thinking in mathematics, from the thinking that goes on in learning a new language, from appreciation and evaluation in the arts; are these different from the thinking that occurs in solving the practical problems of everyday life?

Answers to these questions can be provided neither by the causal analysis of reinforcement theory nor by the pragmatic, instrumental morality of knowledge for use. These--reinforcement theory and pragmatic morality--are both monistic. The first holds, correctly I think, that the same principles of learning operate whether we are learning algebra or Arabic, poetry or the presidents, chemistry, calculus, or color sense. The pragmatic morality says, again I think correctly, that all of these, if taught at all, should contribute to enhancement of life. Very well. But neither can answer our question: How does thinking in science differ from thinking in mathematics, etc., etc.?

Answers to these questions are to be found, instead, in differing sorts of reasons for believing that things we learn are true. A valid reason for believing that water is H_2O is logically different from a valid reason for believing that the square on the hypotenuse is equal to the sum of the squares on the sides for any right triangle. The first involves interpretation of concrete experiments, the second purely abstract geometrical relations. A valid reason for believing that the infinitive ought to be put at the end of a German sentence is just that this is the absurd way the language is spoken. A valid reason for believing that the Guernica is a superb painting is, however, enormously more complicated than that.

A theory of subject matter worthy of our attention is one that distinguishes clearly and correctly amongst these varying kinds of reasons. It might do that very well, however, and still not be a good theory of subject matter. It could be a good sociology of academic disciplines without being in the least useful as a guide to teaching subjects in school. In order to be useful it would have to suggest how reasoning can be taught in various subject matters. It would have to indicate how various levels of complexity in thinking within the various subject matters correspond to various stages of development in youngsters. It would need, finally, to be embedded in a general scheme of curriculum such that the autonomy of the parts does not entail chaos in the program as a whole, but to this final matter we will return later.

This is what I mean by a conception of subject matter. Does it, however, resolve the dilemma posed a moment ago? Here we confront the crux of the argument: if we turn the instructional problem over to programmers, they will ask us: What responses do you want your students to make at the end of the period of instruction? We could answer in this way: At the end of a course in geometry, we want our students to respond by saying "formal, abstract, and deductive" to the stimulus. "What kind of reasoning is exhibited in a geometrical proof?" A good programmer would have no great difficulty in eliciting this response at the end of a rather short sequence of frames. But is this what we mean when we say that we want our learners to know the right reasons for thinking that one proof in geometry is valid and another not? The answer is obviously no.

We can resolve the dilemma between reasons for believing and causes of thinking only when the reasons are built right into the causal sequence for changing behavior, i.e. the frames of the program itself. It is not impossible to cause students to reject cues concerning the size, thickness, and color of lines on triangles looked at as specimens for geometrical proof and to attend very carefully to these same cues when looking at triangles as illustrating principles of esthetic design. A student could be caused to regard a sentence as merely showing conventional ways of talking in a given

language community or as showing the particular genius of a poet. If he had been caused so to regard the world around him and to say, on proper stimulus, how he regards the world, he would have learned, ipso facto, what I am calling here the right reasons for believing what he has been taught.

I say he could be caused so to behave. But when I survey the enormous gulf between educators on one hand and the research in learning theory on the other, I have no reasoned hope that this sort of teaching will actually take place. On the contrary, it seems to me most likely and most unfortunate that those developing programs, either for experimental or commercial purposes, will put into them just what is easiest to program, and that is not reasons but simple responses. It seems very likely also that school administrators, with somewhat guilty consciences, will utilize the new technology for doing the dirty tasks they do not really approve, namely, causing students to respond correctly to the questions set by College Board Examiners. Both these are far from being a response to Prof. Skinner's original call for sweeping revisions of our educational program and far also from meeting the moral demands on us as educators.

Let me turn, then, in conclusion to the third conception that must be revised if we are effectively to use our new technology.

3. A conception of a school program. What happened to the morality of subject matter, i.e. to the belief that what is taught should contribute to improving the quality of living in learners? Can this educational equivalent of the Hippocratic ethic in medicine be preserved in an age of machine teaching? In principal, yes. Indeed the new technology of instruction could be for education what the new technology in treatment was for the medical profession beginning about a century ago. But as with medicine, it will require a revolution in social organization, and we must face paying the costs attendant on any revolution.

The older pragmatic notion had it that learning improved the quality of living when the learner used what he had learned in solving his immediate problems. I discussed earlier that this also gave the learner a unique reason for believing what he had learned. But in any concrete sense, we don't use, cannot use, would be foolish to try to use most of what we ought to learn in schools in solving immediate problems. This argument is quite familiar. If we have problems with our radio we don't use our knowledge of physics but the Yellow Pages. The most solid achievement of a highly technological and specialized society is that we don't have to solve our own immediate problems; there are technical resources--human and mechanical--to solve them for us.

But the cost of this achievement is alienation, not in the psychiatric sense but in the ordinary sense that most of us have little awareness of nor control over the events and forces that impinge on our daily lives. Most of us lack not only the skill of the expert but even the skill to apprehend why and how he behaves as he does. I take it that under these conditions "improving the quality of life" means something very different from what it meant in an agrarian society when most individuals and families had to solve their own immediate problems for themselves. Today we improve the quality of life by giving a youngster the intellectual and verbal skills that will enable him to create meaning and order out of the complex, often chaotic, world in which he finds himself.

I see the teaching machine, that often ugly piece of gadgetry, as our only hope for improving quality of life in this difficult sense. By means of this machine and only by this means, could we give effective and individually differentiated instruction in the complex skills and knowledge necessary for all contemporary citizenship. Properly programed, these machines could teach the reasoning inherent in scientific theory and technology, in the historical reconstruction of our past, in principles of order and design in the arts, in enough languages to give a citizen of this country access to other cultures and traditions. Properly programed and properly used, these boxes are our best hope for education.

Proper programing, as I have suggested, consists of building right and valid reasons for belief right into the sequence of frames that causes thinking to go in a certain way. This is much more difficult than it might appear. It should be easiest in mathematics, for there, the right reasons are purely structural in the program itself. The right reason for believing the Pythagorean theorem is that it can be deduced from certain axioms according to certain rules. But the programmer with an eye on standardized test scores finds it tempting to skip the reasons and just teach the proof. In science, reasons become more difficult to teach, not only because inductive logic is more complex than deductive, but also because there are different kinds of reasons in differing sciences and in different levels of any one science. When we consider history or the arts, reasoning is more complex still.

The danger here is that we tend to teach what is most easily teachable. It is much easier to teach that Germany started World War II than to give youngsters reasons to believe that this was so. We have rejected the idea that a valid reason for believing that Germany started World War II is that a textbook or teacher said so. It is even less responsible to hold that Frame 74 in Program History which reinforced that response is a reason for believing it. The danger of teaching the most easily teachable does not lie only in

programed instruction; poor teachers, lacking personal or academic confidence, have been doing this most of the time. But programing has two special obligations: First, since programs are, or should be, developed by persons of high competence, there is no excuse for poor programing as there is for deficiencies in an often underpaid and undertrained classroom teacher. Second, the programmer begins with a theory that recognizes only causes for thinking; he must, therefore, be particularly careful that reasons for belief are not ignored.

Following on the morality of subject matter mentioned above, I can now make the connection. Subject matter taught by machines or otherwise is morally justified if, and only if, it contributes to enhancing the quality of life for the student. Programs which merely cause thinking to go in certain ways cannot meet this demand; programs which teach reasons for believing those things a person needs to understand in order to make sense out of this world do meet these demands. But if the reasons are not built directly into the program, a requirement that makes the already difficult art of programing even more arduous, the defect cannot be made up by the classroom teacher.

If this is what is meant by proper programing, what would be a proper use of these programs in the total curriculum of a school? It would mean, I think, using in a distinctively human way the power of social reinforcement inherent in the role of teacher. The teacher presents as well as represents the adult society at large in the life of the learner. Freed from the task of routine instructing--as Prof. Skinner says "Marking a set of papers in arithmetic--'Yes, 9 and 6 are 15; no, 9 and 7 are not 18'--is beneath the dignity of any intelligent individual"--freed from that, a teacher could do two things over that are all too seldom or poorly done in most schools today:

First, he could show what the intellectual resources of our culture can mean in the lives of adults in this society. A man who is himself fascinated by mathematics or poetry could present himself and his study for emulation by youngsters who are already well enough instructed to follow what he says, and hopefully, follow him as a person and a scholar. This kind of person is always rare. We'll probably have to share the few that are available.

Second, the teacher could help youngsters at every stage of development to overcome the alienation inherent in our kind of social order. Working with individuals and small groups, he could himself recognize and help the youngsters to recognize their own problems; he could, more directly, reinforce the often tentative groping, but honest responses of youngsters as they seek to make sense out of the apparent senselessness of modern life. Our problem

here is to provide a distinctive kind of training for the large number of teachers required in this operation.

You can see, I think, that our efforts to keep the role of teacher single and undiscriminating, our egg crate conception of school architecture, our notions of lay control, and all the rest of our mythologically based ideas of education will have to go when we begin to take the programing seriously. But that is exactly what we will have to do. For, if the history of technological change is any guide, it seems clear that if we do not take these machines, they they will take us. I should much prefer that we take them into the main stream of educational practice rather than leaving them on the outside as marginal and distractive influences.

I can see clearly only the first step; it is this: the main task of in-service and pre-service training for every teacher and administrator is to develop the skills and attitude of programing. Only if we do this can we be sure that the basic morality of democratic and liberal education will be built into programed teaching for our youngsters. With no disrespect to research psychologists nor to commercial vendors of programs and machines, we cannot afford to let them nor any one else assume the basic responsibility that has been delegated to us as educators.

It would be quite presumptuous of me to advise the MSSC how it should exercise its obligations. But I must add this word in closing: a group of schools, favored economically and favored in its access to the intellectual resources of this metropolitan region, cannot afford to let presently good education stand in the way of innovation, stand in the way of exercising leadership for our national system of education of which it is inescapably a part.

"The Limitations of Present Teaching Machines"

(Notes on Mr. Komoski's Presentation)

**P. Kenneth Komoski,
President of the
Center for Programed
Instruction**

In Mr. Komoski's opinion, the commercialization of the teaching machines must be viewed with caution. While there are over 100 companies making or designing teaching machines, there are fewer than a dozen complete and thoroughly tested programs available to put into these devices.

It is Mr. Komoski's view that present machines are too inflexible and cannot adapt themselves to programing except that for which they were designed. Since Programing, or subject presentation, is the essential part of the process, this inflexibility is an indication that machine technology has not kept pace with advances in programing.

The art of programing becomes the art of compromising when the programmer accepts the limitations of the present machines and what the programmer would like to do becomes subservient to what the machine will allow you to do.

As a consequence, Mr. Komoski does not encourage boards of education to purchase machines until present restrictions are replaced with complete flexibility; otherwise, there is a danger teachers, just now beginning to understand the potential and art of programing, will be inadvertently restricted through the adoption of immature machines.

The Center for Programed Instruction, recent recipient of a \$300,000 grant from the Carnegie Corporation, will continue to concentrate its attention on the translation of research findings into practical classroom applications. The Center, a non-profit educational organization incorporated in the State of New York, has grown out of the work begun two years ago by the Collegiate School's Automated Teaching Project. Mr. Komoski, President of the Center, has been a teacher and administrator at the Center for the last eight years.

The Center sets for the its purpose the following objectives to serve the educational community:

- i. Consulting with and aiding schools interested in carrying on projects in the fields of programed instruction and/or teaching machines.

2. Creating thoroughly tested programs of instruction in all subjects. These programs will reflect current curriculum advances.
3. Conducting controlled research to investigate programing variables and administrative techniques of implementation of programed instruction. The object of these studies will be improvement of programing techniques and the development of a well articulated relationship between programed instruction and other instructional media.
4. Supplying experimental programed learning materials to schools interested in conducting trials of such materials.
5. Disseminating objective information about programed instruction and teaching machines. It is the object of the Center to make it possible for all educators to obtain the information and evidence they need if they are to make intelligent judgments regarding the use of programed instruction and teaching machines.
6. The Center plans to conduct in-service workshops in cooperation with school systems, teachers' colleges, and universities. The purpose of these workshops will be the development of resource personnel for particular school systems concerning programed instruction and related fields. Particular emphasis will be given to the effect of programed instruction on the role of the teacher and the relationship between programs and all other methods of instruction. Training in programing will also be provided to teachers, administrators, authors, publishers, and others interested in creating high-quality programs.

Reconstruction of presentation --

English 2600

John MacGowan,
8th Grade Teacher,
Manhasset, N. Y.

It is my pleasure to be here today to report to you my stimulating experience of the past two months working with English 2600, A Scientific Program in Grammar and Usage published by Harcourt, Brace and Company.

English 2600 is a teaching machine in book form. It looks like many workbooks, but it is far different. Workbooks are usually used to give a whole class of students practice in a particular lesson while English 2600 is designed to allow individual students to proceed at their own speeds through a typical year's course.

When Manhasset Junior High School decided to purchase this book, it was planned to find if it worked and with which students. Therefore, we are conducting a limited experiment in which approximately 800 students are participating. Twenty-five seventh graders, fifty-five eighth graders, eleven ninth graders, and fifty tenth graders are using this book, while the remainder compose the control group. All 800 have been pre-tested and will take a final test late this spring. All 800 are now assigned to some kind of English class. With the book and our own answer sheets we have practically duplicated the machine shown on this platform by Hamilton Research Associates this morning.

In my classroom I have established a routine for the period during which the book is being used. The period of actual work with English 2600 is thirty minutes a day, three days a week. In establishing this routine every effort was made to develop strong class morale. All the teachers in the program feel this is most important to success in using this book. The value of this book for individual self improvement has been emphasized, and the negative motivation of competition has been de-emphasized.

If you could visit the classroom, you would see something like this: The students would be absorbed with their work so that the observer would feel he was watching a typical testing situation. My desk would be covered with the 13 tests which are part of the program. There are eleven units of work and there is a test for each unit in addition to a half-way test and a final test. There are 458 frames in the first unit, and, when a student finishes them, he comes to the desk and asks for the unit test. I give it to him, and he returns to his seat and does it. This takes about ten minutes. He, then, returns

the test to me for correction. I can do this in about two minutes, and I immediately tell him the result. If he has no errors, I tell him to proceed. If he has only a very few errors, I spend a minute or two with him letting him find his mistakes before letting him proceed. On the other hand, if he has less than a typical 95% paper, I send him back to the particular frames which should aid him, and I instruct him to return for another test before proceeding with unit 2. This same procedure is followed as he proceeds through the program.

This pin-pointing of student error, and the speed with which it is brought to the attention of the student are among the most attractive features of using the 'machine.' A possible improvement in English 2600 would be the inclusion of different material for restudy after the first failure. Returning the student to the unlearned material has had very valuable results in several cases. The most dramatic is the case of a boy who did very poorly on the test for unit one, but who has subsequently completed it and four others without a single mistake.

Sometimes as many as a dozen tests are given in a single session in my class of 28. Probably no more than three of these tests are on the same unit of work. Keeping up with the clerical and professional work involved is a real taskmaster for the teacher. This leads me to caution anyone who feels that he would like to use a machine to avoid work to think again. I find that the machine makes me work harder, it makes the students work harder, and it makes the 'office' work harder. I feel that this is true of all the machines I have ever worked, and it certainly is true of this one. The program has been a real inspiration to some of the students, but a group I would characterize as "party lovers" hate this kind of class. After all, you can't have much fun if every one is grinding away at work. And where is the audience for a good joke? Furthermore you have to read and write all by yourself without a teacher to "spoonfeed" the lesson for you.

I would list the following four advantages as strong recommendations for using this machine.

- (a) It eliminates the problem of loss of instruction due to illness, trips, etc. as well as the problem of deciding how to work a new student into the classwork.
- (b) It presents each student with a good English grammar course of study which he can complete at his own pace.

- (c) There is a great saving of time for individual students. The best students in my class are completing a typical year's work in grammar in $12\frac{1}{2}$ hours.
- (d) It pin-points student errors thus directing study to the material which needs concentrated study.

I find that the next great need is for a complete English course. I will have some students with all the work complete while others have months ahead of them. Therefore, I need more grammar, an individualized program in literature and composition, and other materials to offer these students and the time to offer them in. Immediately, I am sure, you can see the implications of this for teachers (professional and non-professional) space, time, and materials.

Vendors of Teaching Machines and Teaching Programs

Three vendors, representing a cross-section of available commercial machines and programs, were invited to participate in the All-Council Meeting by displaying and explaining their equipment in separate rooms to groups of conference participants that rotated among them on a pre-arranged schedule. These manufacturers are in no way endorsed by the Council. Detailed information is available directly from the vendors:

Basic Systems, Inc.

Dr. Francis Mechner
42 East 52nd Street
New York City

Office: PLaza 2-3560
Home: Riverside 9-2421

Basic Systems, a corporation formed by a group of people mainly from Columbia University and Yale University, is currently developing a wide range of teaching programs. The emphasis of these programs is in the direction of basic science and mathematics.

Hamilton Research Associates

Mr. J. W. Blyth
4 Genesee Street
New Hartford, New York

Business Telephone: RE 5-7566

or

Mr. J. W. Blyth
c/o Hamilton College
Clinton, New York

Hamilton Research offers a machine, the Visitutor, using cards for programing. Hamilton is also interested in developing new programs. Price: \$89.50.

Rheem Califone Corporation

Rheem Califone Corporation
1020 North La Brea Ave.
Hollywood 38, California

or

Mr. William E. Spaulding
Rheem Califone Corporation
400 Park Avenue
New York City

Business Telephone: ELdorado 5-3400

Rheem has in production the Didak 501, a machine which utilizes fan-folded paper tapes on which the program is printed, typed, or drawn. Price: \$157.50.